Quantification of T-1 Cost Effectiveness

October 8, 2008

Overview

Actions being considered by all Implementation Working Groups (IWG) are being evaluated in terms of GHG emission reduction potential and cost-effectiveness (in terms of $/MtCO2e). Calculation of cost-effectiveness requires estimate of the net social cost of the action.

The net social cost of transit expansions in Washington State can be estimated according to the following formula:

Cost of transit investment	=	(1) transit operating costs, capital maintenance costs, capital expansion costs	-	(2) societal cost savings from reduced vehicle travel

This memo presents our calculation of the cost of transit investment for the year 2020 only. In order to estimate cost-effectiveness on terms consistent with other IWGs, we will need to estimate the net social cost over the entire analysis period (2008-2020), which involves summing annual costs during that period and applying a discount rate.

Transit Operating and Capital

Information on transit costs by mode and program is drawn from the following sources:

1. Bus and vanpool – information provided by IWG
2. CTR/GTEC – information provided by IWG
3. Residential Trip Reduction – information provided by IWG
4. VMT Reduction Innovation Grants – information provided by IWG
5. Amtrak – Washington State Long Range Plan for Amtrak Cascades
6. LRT and Commuter Rail – ST2 Financial Plan, May 2007

Not all sources separate the cost of proposed transit expansions from the cost of maintaining existing service. As a result, we use the total cost of transit service and transit-related programs. This adjustment requires that we calculate the cost effectiveness of all transit service in 2020, rather than the cost effectiveness of only new transit service.

Where the proposed transit investments require significant capital investments that may not be evenly spread across years (rail transit), we include in the year 2020 total the average annual capital investment amount.

Inflation Adjustments

Cost information for components 5 and 6 are quoted in year 2006 dollars (2006 $). We assume that cost information for components 2-4 are quoted in comparable terms. Cost information for bus and vanpool (component 1) are calculated using a 4% annual inflation rate. We assume that

this rate includes 2.5% annual monetary inflation, and 1.5% annual real cost increase. We deflate the cost figures accordingly to represent them in 2006 $.

Results

Total transit expenditures in Washington State in the year 2020 (2006 $) are estimated at $2.6 billion, as shown below.

	Annual Cost (2020)	Source
Bus/Vanpool/Paratransit	$2,166,782,597	WSTA/Intercity Transit
CTR/GTEC	$11,100,000	CTR-GTEC additional information 07-30-08
Residential Trip Reduction	$22,100,000	Residential Trip Reduction Additional Info 7-30-08
VMT Reduction Innovation Grants	$2,500,000	VMT reduction innovation grants additional information 07-30-08
Amtrak	$383,909,524	Long-Range Plan for Amtrak Cascades
LRT and Commuter Rail	$13,947,368	ST2 Financial Plan, May 24, 2007 (avg. annual expenditures over 2008-2027)
Total	$2,600,339,489	

Societal Cost Savings

Societal cost savings from reduced vehicle travel can be estimated following a methodology developed in a study conducted for the Minneapolis-St. Paul region in 2000.[1] The study calculates the total societal costs of all existing on-road transportation activity in the region. Costs are subdivided into costs paid by the government (governmental), costs paid by vehicle drivers (internal), and costs paid by other people (external). We adapt this framework to calculate marginal cost savings that can be expected from shifting trips from private vehicles to transit.

The table below lists the types of costs examined within each of these categories, along with our decision to include or exclude each component from our calculation. Many of these costs will not vary substantially in response to an expansion in transit service within our short time frame (to 2020). For the sake of simplicity, we propose to ignore costs that are not clearly affected by marginal changes in VMT such as those expected in response to the transit expansion. Approaches to calculating each component are provided below. Each component is calculated as savings per VMT reduced, multiplied by total VMT reduced. In accordance with the calculation of operating and capital costs above, we calculate the cost savings associated with all VMT reduced by transit systems and transit-related programs in 2020.

Transportation Cost Elements: Proposed Treatments

[1] Anderson, David and Gerard McCullough. The Full Cost of Transportation in the Twin Cities Region. University of Minnesota, August 2000.

Cost	Included	Reasoning / Approach
Governmental Costs		
Streets and Highways	no	negligible impact from transit expansion
Transit	no	included in part (1) of the equation
Law Enforcement and Safety	no	negligible impact from transit expansion
Environmental Cleanup	no	negligible impact from transit expansion
Energy Security [i]	no	negligible impact from transit expansion
Parking [ii]	no	negligible impact from transit expansion
Costs to Other Agencies	no	negligible impact from transit expansion
Internal to driver/owner		
Fixed and variable vehicle costs	partial	variable vehicle costs only
Transit Fares	no	included in part (1) of the equation
Travel Time	no	assume no change in travel time from switching to transit
Other Personal Time [iii]	no	negligible impact from transit expansion
Crashes	--	internal crash costs covered under external costs below
Parking and Driveways	partial	capital costs are excluded, due to negligible impact from transit expansion
External to driver/owner		
Congestion	yes	clear variance with VMT
Crashes	yes	clear variance with VMT
Air pollution [iv]	yes	clear variance with VMT
Global warming	no	GHG reductions are captured as a benefit of transit expansion
Noise	no	negligible impact from transit expansion
Fires and Robberies	no	negligible impact from transit expansion
Petroleum Consumption [v]	no	national base value cannot be estimated with confidence, and expected impact of transit expansion is small

[i] Energy security costs include ethanol subsidies, R&D to improve energy security, costs of maintaining the Strategic Petroleum Reserve, and military expenditures
[ii] Parking costs include free and subsidized parking spots provided by government agencies
[iii] Other personal time includes time spent maintaining, buying and selling, and learning to drive vehicles
[iv] Air pollution costs include impacts to human health, visibility, crops, materials, and forests
[v] Petroleum consumption costs include losses to GDP due to oil price fluctuations

Variable Vehicle Costs

We calculate the cost savings to vehicle owners from reduced driving. Only costs that vary by miles driven are included. We assume that the transit expansion will not reduce total auto ownership, and will therefore not reduce any fixed vehicle costs (such as insurance and registration). Cost components that vary with VMT include fuel, depreciation, and maintenance and tires. Average costs for the latter two components are drawn from a driving cost calculator provided by the Santa Cruz County Regional Transportation Commission.[2] Fuel costs per mile are calculated using current fuel prices in Washington State ($3.58 per gallon)[3] and projected average fuel economy for light duty vehicles in 2020.[4]

[2] http://www.commutesolutions.org/calc.htm
[3] http://www.fuelgaugereport.com/sbsavg.asp
[4] Energy Information Administration, Annual Energy Outlook 2008. Table A7.

Parking (Internal)

A report by the Victoria Transportation Policy Institute estimates the average amount that drivers pay for tolls and parking for each mile driven.[5] We apply this cost to the expected reduction in urban VMT only, based on the conservative assumption that non-urban trips are unlikely to involve paid parking or tolls. We conservatively estimate that the urban share of VMT reductions from transit will be equal to the share of total statewide VMT that falls in urban areas (71%).

Congestion

The Texas Transportation Institute's (TTI) Urban Mobility Report provides comprehensive data on roadway congestion in urban areas. For each urban area, the report estimates the cost savings associated with the congestion reduction benefits of transit. For the Seattle area, the most recent report estimates that 1.06 billion passenger miles traveled on transit in 2005 saved $225 million.[6]

Consistent with our calculation of VMT reduction from the proposed transit expansions in Washington State, we assume that each transit passenger mile traveled on Seattle transit replaces 0.5 miles of VMT. The average congestion cost savings associated with one mile of VMT reduction in Seattle is therefore estimated at 43 cents.

We apply 43 cents of cost savings to each mile of VMT reduced by transit in the Seattle area. We assume that the Seattle area's share of statewide VMT reduced will be equal to the PSRC region's projected share of total statewide VMT in 2020.

This calculation assumes that there are no significant cost savings from congestion reduction outside of the Seattle urban area.

Crashes

We estimate the costs of vehicle crashes based on a report from the National Highway Traffic Safety Administration (NHTSA). NHTSA calculated the economic costs of both bodily injury and property damage from crashes of different severity.[7] Using this data, we calculate the average cost by crash type.

The impact of VMT reduction on crash rates is inferred from WSDOT data on annual vehicle crashes.[8] We calculate the incidence of crashes of different severity in Washington State per 100 million VMT. We then calculate the number of each type of crash that will be avoided annually because of VMT reduction from transit. We apply the average cost by crash type, calculated above, to estimate total savings from reduced accident rates.

[5] VTPI, Transportation Cost and Benefit Analysis
[6] Texas Transportation Institute, 2007 Annual Urban Mobility Report.
[7] NHTSA, The Economic Impact of Motor Vehicle Crashes, 2001
[8] WSDOT, 2006 Washington State Collision Data Summary Statewide – All Roads

Air pollution

A report by the Victoria Transportation Policy Institute estimates the cost of air pollution imposed by one mile driven in an average car. The cost estimate includes impacts on human health, agriculture productivity, ecological resources and aesthetic quality.[9] We apply this cost figure to our VMT reduced, subtracting costs imposed by GHG emissions, which are represented elsewhere in our calculations.

Inflation Adjustments

All cost figures are adjusted to 2006 $ using historical inflation data from the Consumer Price Index.[10]

Results

Total societal cost savings are calculated for low and high VMT reduction scenarios, which correspond to the low and high GHG reduction scenarios.

Scenario	Total VMT Reduced in 2020 (billion)	Cost Savings (billion)
Low	2.0	$1.5
High	2.7	$2.0

Cost Effectiveness

The total cost of transit is calculated according to the formula above. In order to calculate cost effectiveness, we must estimate the total GHG emissions reduced by all transit service and transit-related programs in 2020. Our previous exercise calculated the additional reductions from new investments between 2006 and 2020. We scale up those reductions using the following factor: VMT Reduced by Transit (2020) / Change in VMT Reduced by Transit (2006-2020)

The table below shows the resulting 2020 ranges from approximately $1,000 to $3,000 per metric ton of CO2-equivalent.

Scenario	Operating and Capital Costs (billion)	Social Cost Savings (billion)	Net Cost of Transit (billion)	Total GHG Reduction in 2020 (MMtCO2e)	Cost Effectiveness ($/MtCO2e)
Low	$2.6	$1.5	$1.1	0.36	3,072
High	$2.6	$2.0	$0.6	0.59	999

[9] VTPI, Transportation Cost and Benefit Analysis
[10] http://data.bls.gov/cgi-bin/cpicalc.pl